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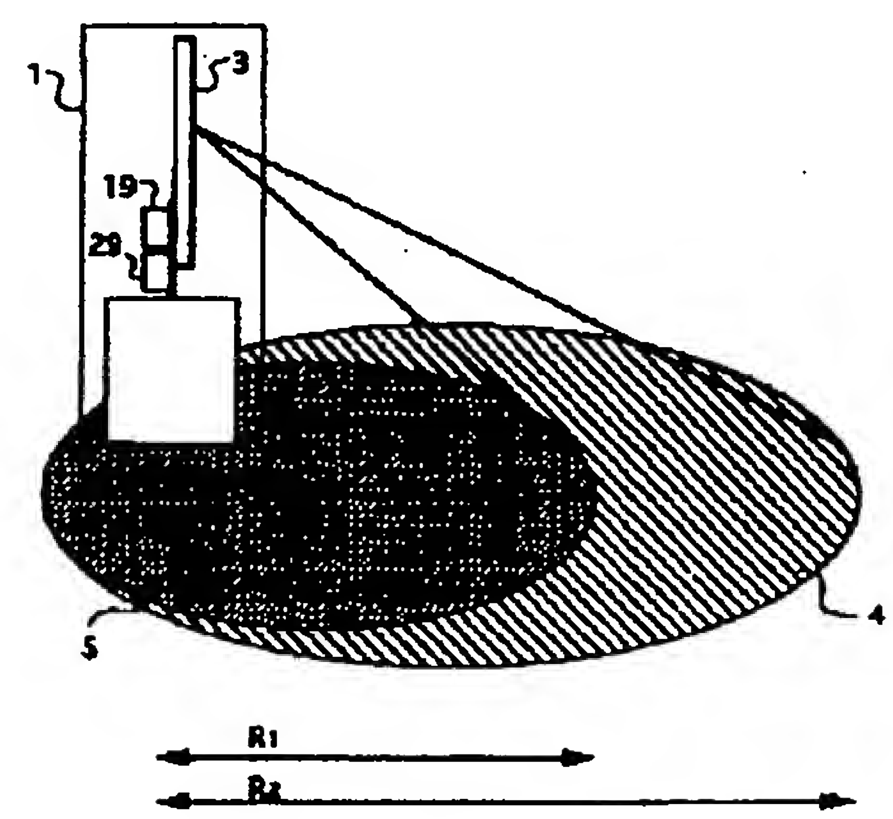
(54) ZONE REVISION SYSTEM IN MOBILE COMMUNICATION

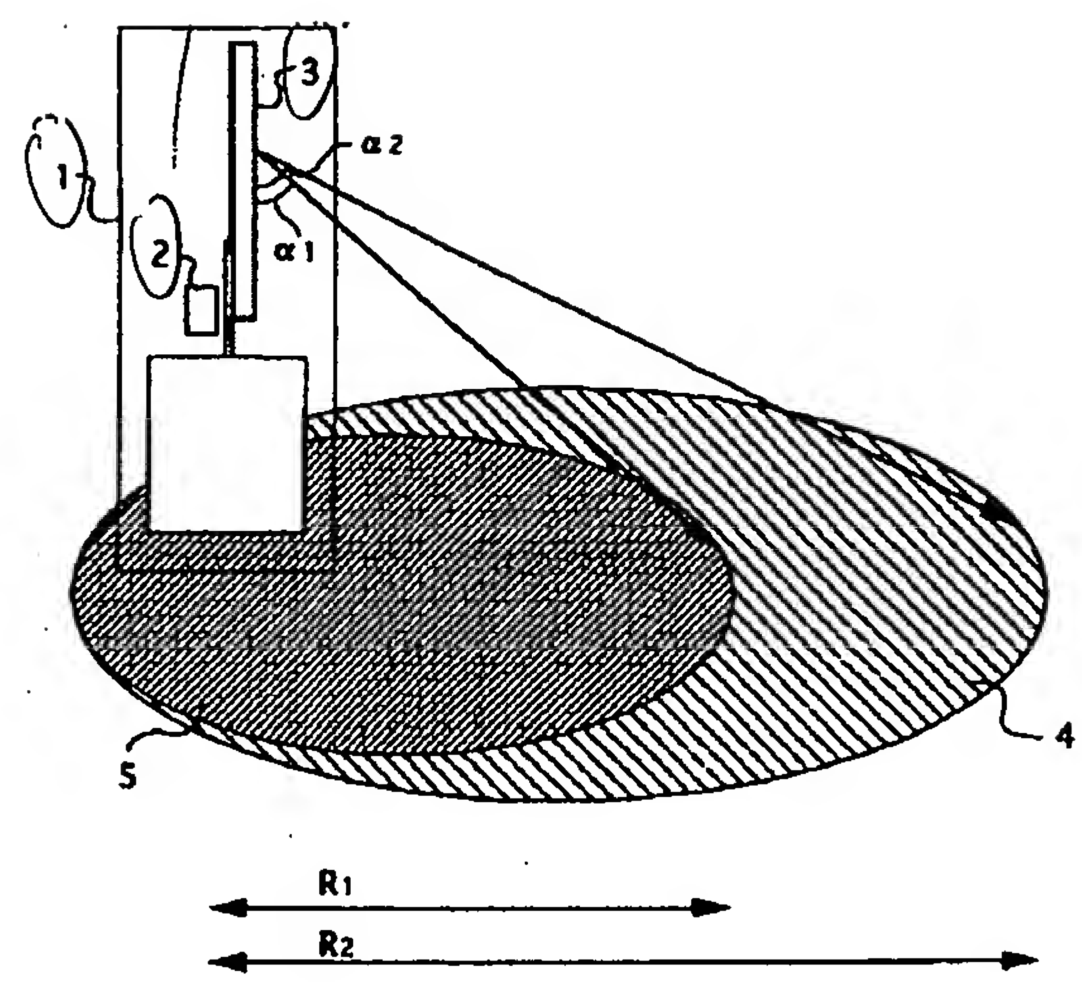
(57) Abstract:

PURPOSE: To revise optionally the extent of a zone covered by a base station by adopting the configuration such that the directivity of an antenna of a base station is quickly changed in mobile communication.

CONSTITUTION: The extent of zones 4, 5 in which a base station 1 makes communication with mobile stations is easily revises as required by providing a directivity revision circuit 19 changing optionally the directivity of an antenna 3 in its vertical plane and a controller 29 controlling the directivity revision circuit 19 to the base station 1 in mobile communication. Furthermore, the zones of the plural base stations 1 are controlled simultaneously to set the control of zones depending on the occurrence of calls dynamically on the occurrence of lots of calls.



【図1】



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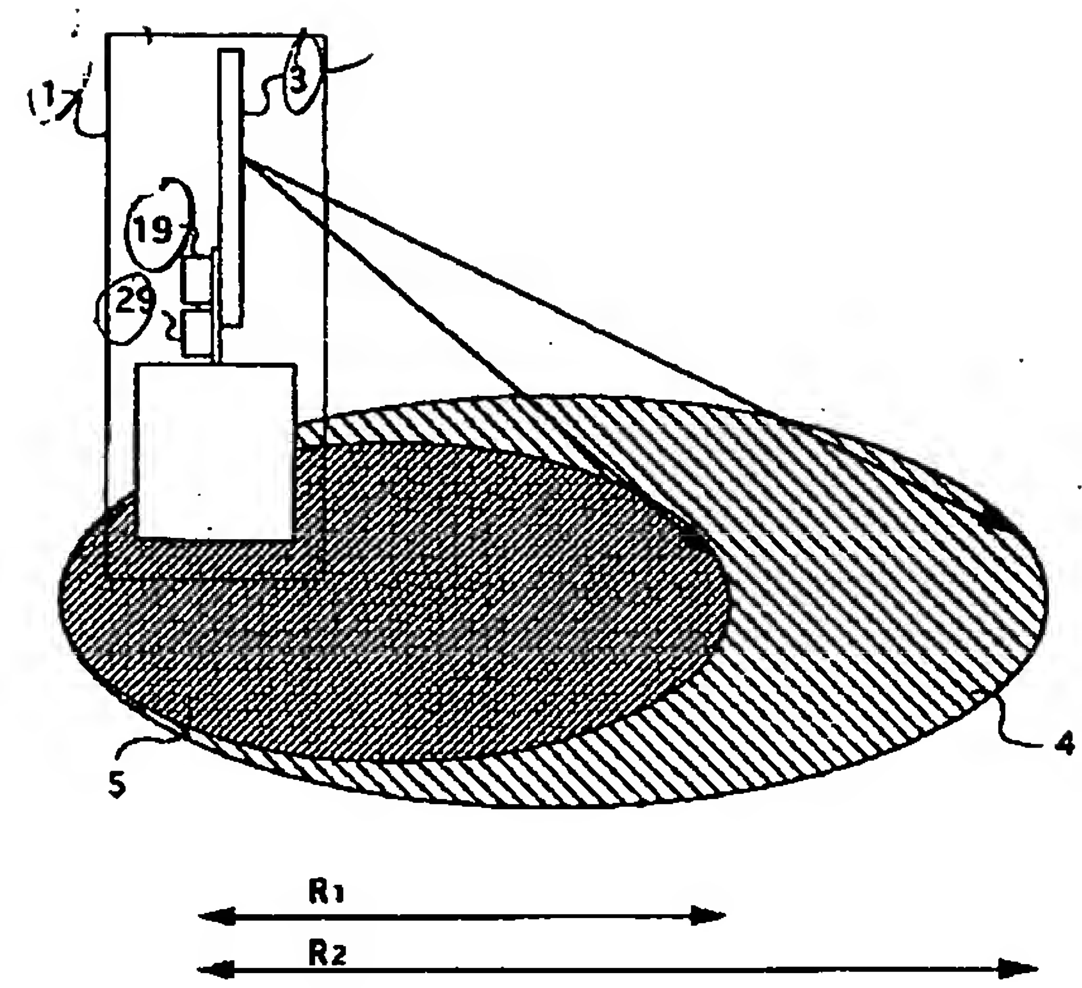

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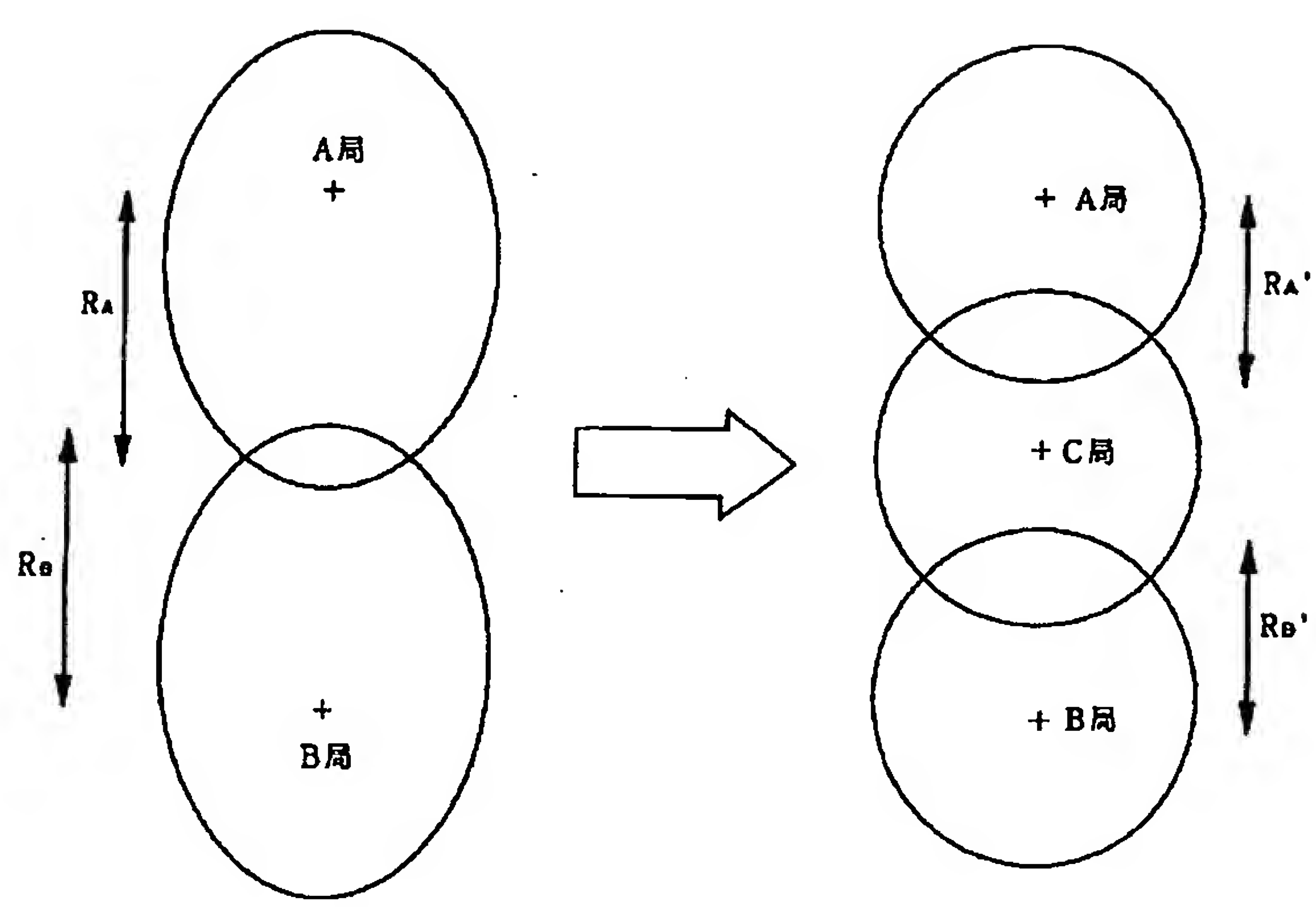

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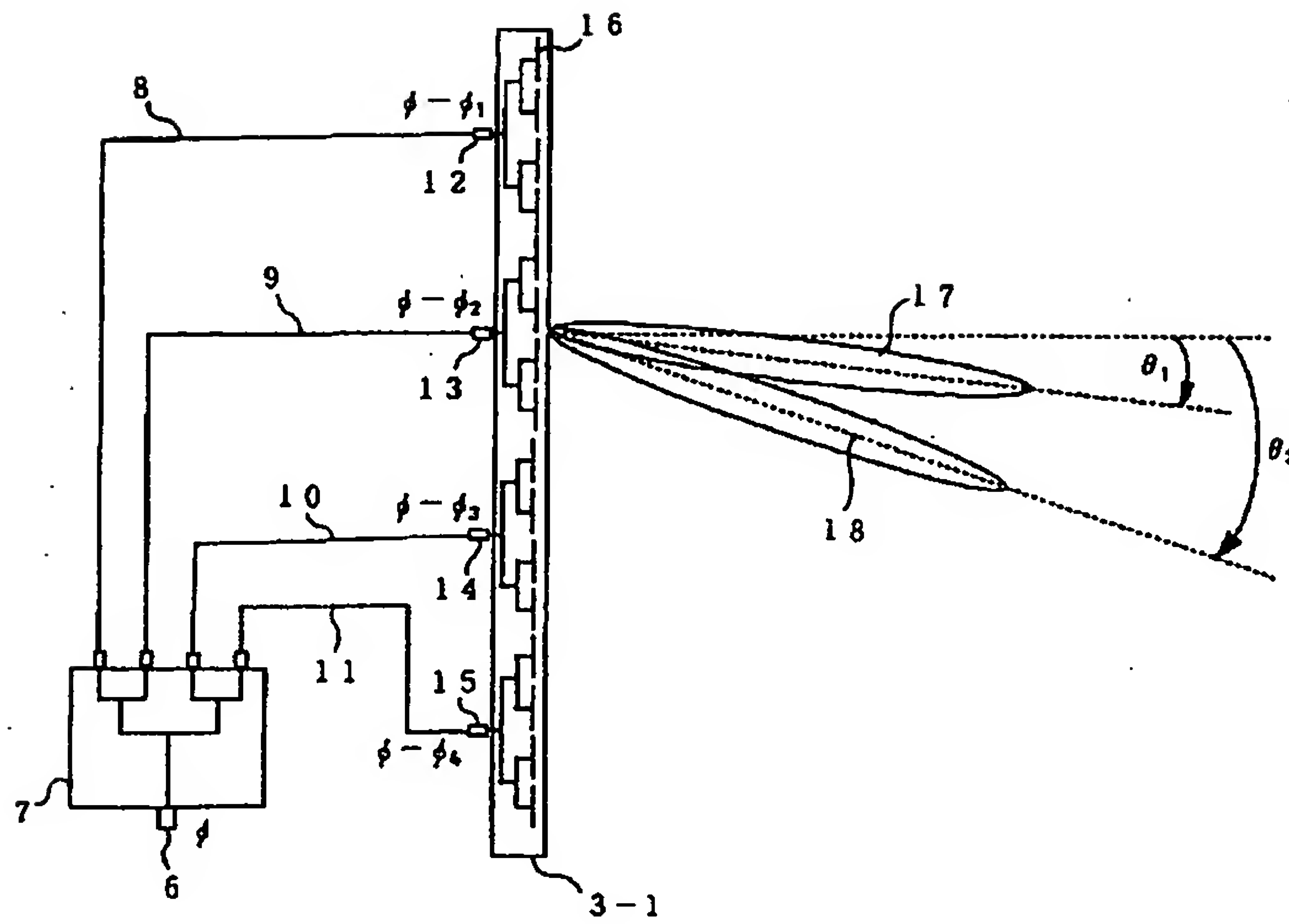
16
8
$\phi-\phi_1$
12
9
$\phi-\phi_2$
13
17
θ_1
θ_2
18
10
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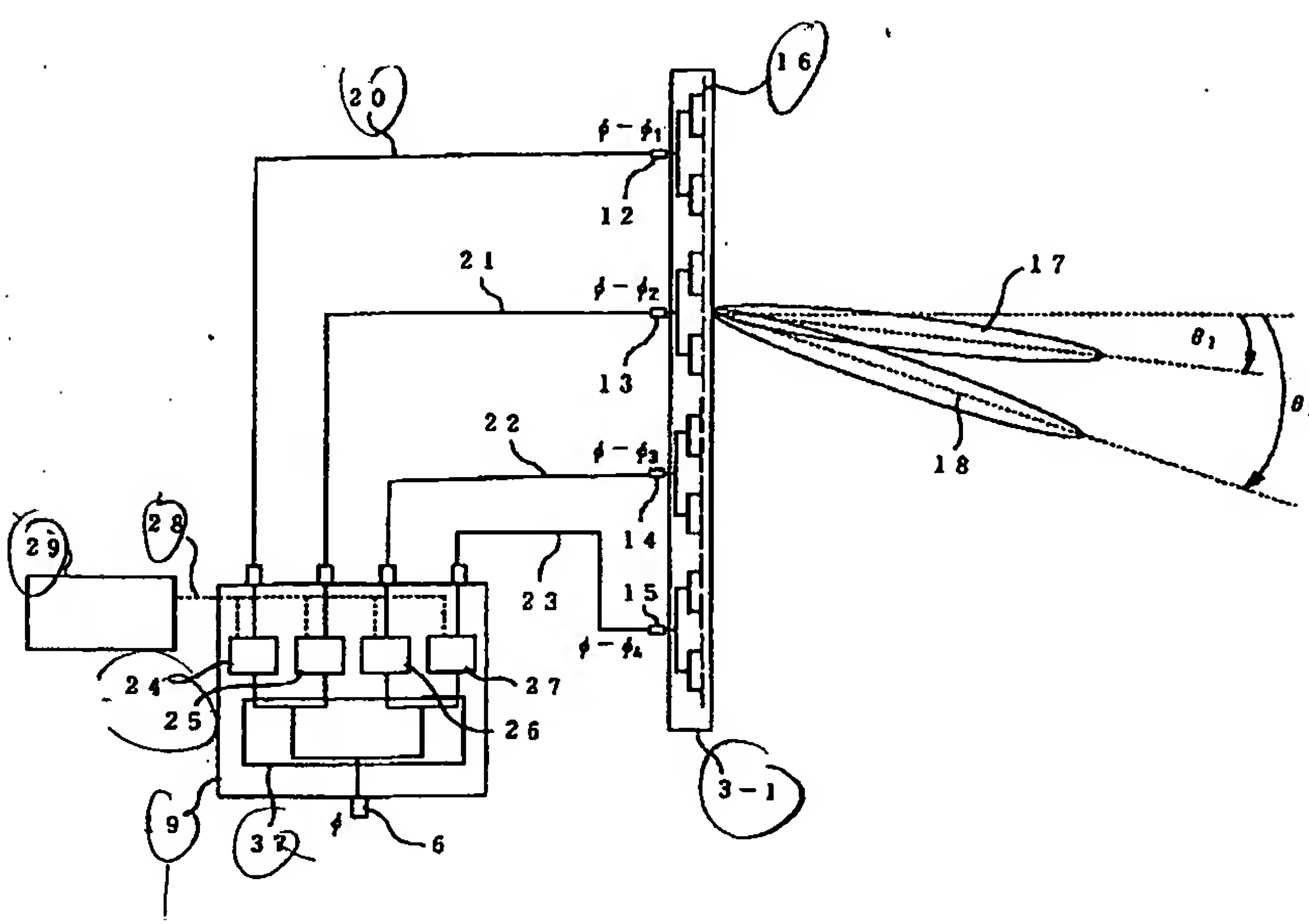
14
11
15
$\phi-\phi_4$
7
ϕ
6
3－1

【図５】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37
ϕ
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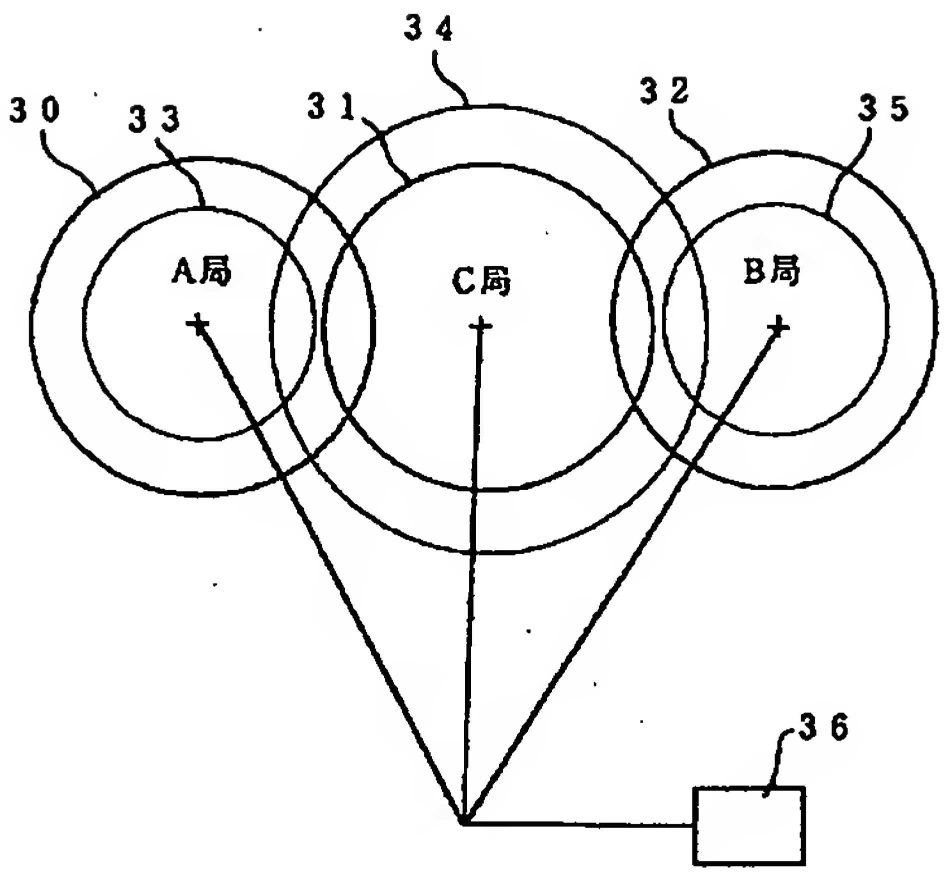
【図6】



Scope of Patent Claims

Claim Clause 1: This system changes the zones in which base stations communicate with mobile stations when mobile communications are being used. The system provides direction change devices that make it possible to change the directionality inside the vertical planes of the antennas at the base stations discretionarily, and the system provides a control device that controls the corresponding direction change devices. The system is a zone-changing system that features easy changing of the size of zones when necessary by changing the directionality of the aforementioned antennas.

Claim Clause 2: The zone-changing system mentioned in Claim Clause 1 features the aforementioned antennas, which are array antennas, and the aforementioned direction change devices with the ability to change the directionality of the aforementioned antennas by changing the phase of the transmitted signal supplied to the array antennas.

Claim Clause 3: The zone-changing system mentioned in Claim Clause 1 features the aforementioned control device that is connected to everv base station, and this control device controls the aforementioned direction change devices at the base stations where they have been installed.

Claim Clause 4: The zone-changing system mentioned in Claim Clause 1 features the aforementioned control device, with one such device being installed for multiple base stations and controlling the aforementioned direction change devices of multiple base stations.

Detailed Explanation of Invention

-0001

-Industrial Fields Where Used: This invention is a zone-changing system that controls the size of zones that base stations form in mobile communications.

-0002

-Conventional Technology: In mobile communications, the range covered by one base station, or in other words, the communications range from one base station to a mobile station, is called a zone. A zone is also referred to as a cell. A zone is determined by the directionality, etc., of the antenna of the base station.

-0003:

Figure 1 is a figure that illustrates the zone formed by a base station. In Figure 1, the base station is (1), the power distributor is (2), the antenna is (3), and the zones are (4) and (5). (R1) indicates the distance from the base station (1) to the edge of zone (5). (R2) indicates the distance from the base station (1) to the edge of the zone (4). Power is being supplied from the power distributor (2) from the transmitter to the antenna (3).

-0004:

Zones (4) and (5) of base station (1) are determined by the angles $\alpha 1$ and $\alpha 2$, which indicate the directionality inside the vertical plane of the antenna. When the directionality is angle $\alpha 1$, then zone (5) is the communication range of base station (1). When the directionality is angle $\alpha 2$, then zone (4) is the communication range of base station (1).

-0005:

In the case that base station (1) is to form zone (4), then the antenna (3) of base station (1) is set at $\alpha 2$ which makes the directionality inside the vertical plane of the antenna so that the distance of (R2) from base station (1) is the edge of the zone. In the event that it becomes necessary to narrow the range by making zone (5) the zone that base station (1) forms, then the directionality inside the vertical plane of antenna (3) of base station (1) is changed to angle $\alpha 2$, and the distance of (R1) from base station (1) becomes the edge of the zone.

-0006:

Conventionally in mobile communications, when base stations were increased, etc., the zones of the existing base stations have been changed. This is to prevent interference between the radio waves of base stations using the same frequency and to promote the effective use of the frequency.

-0007:

Figure 2 illustrates the case in which the number of base stations is increased. In Figure 2, the zones are changed between two base stations, base station (A) and base station (B), as shown on the left. In this case, the directionality inside the vertical plane of the antenna of the base station is set so that, for base station (A), the edge of the zone is the distance (RA) from base station (A), and for base station (B), the edge of the zone is the distance (RB) from base station (B). To cope with increases in the number of mobile stations inside the zones formed by base station (A) and base station (B), it is necessary to establish a new base station, base station (C), as indicated on the right side of the figure. At base station (A) and base station (B), to promote effective

utilization of frequencies and to prevent radio wave interference with other bases on the same frequency, the directionality inside the vertical plane of the antennas of the base stations must be changed so that edge of each zone is the distance RA' and the distance RB'.

-0008:

Figure 3 is a block figure that indicates the conventional structure that forms the directionality inside the vertical plane of antennas. In Figure 3, the array antenna is (3-1), the supply point (6) is connected to the transceiver installed at the base stations, the power distributor is (7), the supply lines (8), (9), (10), and (11) connect the power distributor (7) and the antenna (3), the power supply points (12), (13), (14) and (15) supply the array antenna (3-1), and the antenna device (16) is arranged in array form inside the array antenna (3-1). Numbers (17) and (18) indicate the directionality inside the vertical plane of the antenna. Also, Ø is the phase of the transmission signal that is supplied to power supply point (6). Ø-Ø1 is the phase of the transmission signal that is supplied to power supply point (12) of the array antenna (3-1). Ø-Ø2 is the phase of the transmission signal that is supplied to the power supply point (13) of array antenna (3-1). Ø-Ø3 is the phase of the transmission signal that is supplied to the power supply point (14) of the array antenna (3-1). Ø-Ø4 is the phase of the transmission signal that is supplied to the power supply point (15) of the array antenna (3-1). θ 1 indicates the angle of antenna directionality 17 from the horizontal position of the antenna. θ 2 indicates the angle of the antenna directionality 18 from the horizontal position of the antenna.

-0009:

Power distributor (7) distributes the transmission signal that is supplied to power supply point (6) in Figure 3, and this distributed transmission signal is supplied to power supply points (12), (13), (14), and (15) of array antenna (3-1) via power supply lines (8), (9), (10), and (11), respectively. By varying the amount of delay at this time through power supply lines (8), (9), (10), and (11), the transmission signals supplied to power supply points (12), (13), (14), and (15) are supplied with the phases changed by just Ø-Ø1, Ø-Ø2, Ø-Ø3, and Ø-Ø4, respectively, in terms of phase Ø of the transmission signal that is supplied to power supply point (6). The transmission signal that is supplied from power supply points (12), (13), (14), and (15) inside array antenna (3-1) is radiated from the antenna device (16) arranged in array form inside the array antenna (3-1). The directionality of the array antenna is determined by the phase of the transmission signal supplied to the antenna device that is part of the array antenna. By changing the phase difference, the directionality inside the vertical plane of the antenna can be changed to make the directionality (17) or (18).

-0010:

With regard to the directionality inside the vertical plane of the antenna (3), by changing the amount of delay in the power supply lines (8), (9), (10), and (11), one can change the phase of the transmission signals supplied to power supply points (12), (13), (14), and (15). Consequently, when directionality is to be changed, the directionality inside the vertical plane of the antenna is changed by switching power supply lines (8), (9), (10), and (11) to power supply lines that cause the required delay.

-0011

-Issues the Invention Attempts to Resolve: When using the method where base station zones are determined using the array antenna indicated in Figure 3, it becomes necessary to switch power supply lines (8), (9), (10), and (11), to which the antenna (3) connects when the number of base stations is increased, as shown in Figure 2, each time there is a change. This entails problems such as the risk due to weather and work environment since it is necessary to work outdoors to switch the power supply lines of the antenna, and service must be stopped when the power supply lines are being switched.

-0012:

If there are two adjacent base stations and the mobile stations inside the zone formed by one base station increase, all of the frequencies assigned to that base station may be used and a deficiency may occur in the frequencies of that base station. At that time, the adjacent base station may have a surplus of frequencies that have already been assigned to it. In this case, if the directionality inside the vertical plane of the antenna of the base stations can be swiftly changed then the zone can be fluidly changed. The frequencies that mobile stations use in the zones of the base stations can be spread fluidly, and communications between mobile stations can be ensured. This enables base stations where mobile stations have increased to change the directionality inside the vertical plane of its antenna and to reduce the size of the zone formed by that base

station, and it enables the adjacent base station to change the directionality inside the vertical plane of its antenna and to increase the size of the zone formed by that base station.

-0013:

However, when an antenna as shown in Figure 3 is used, to change the directionality inside the vertical plane of the antenna, it is necessary to switch the power supply lines connected to the antenna of the corresponding base station. For this reason, a problem exists because responses to the conditions cannot be made swiftly at all times.

-0014:

The purpose of this invention is to make it possible to change discretionarily the size of the zone formed by a base station, by structuring a system so that the directionality of the antennas of the base stations can be changed quickly.

-0015

-Method of Issue Resolution: For the achievement of the above-mentioned purpose, the invention of Claim Clause 1 is a system that changes the zones in which base stations communicate with mobile stations in mobile communications. The system provides direction change devices that make it possible to change the directionality inside the vertical planes of the antennas at the base stations discretionarily, and the system provides a control device that controls the corresponding direction change devices. The system is a zone-changing system that features easy changing of the size of zones when necessary by changing the directionality of the antennas.

-0016:

The invention of Claim Clause 2 is the zone-changing system mentioned in Claim Clause 1 that features the aforementioned antennas are array antennas and the aforementioned direction change devices with the ability to change the directionality of the antennas by changing the phase of the transmitted signals supplied to the array antennas.

-0017:

The invention of Claim Clause 3 is the zone-changing system mentioned in Claim Clause 1 that features the control device that is connected to every base station, and the control device controls the direction change devices at the base stations where they have been installed.

-0018:

The invention of Claim Clause 4 is the zone-changing system mentioned in Claim Clause 1 that features the control device, with one such device being installed for multiple base stations and controlling the direction change devices of multiple base stations.

-0019

-Effects: By providing direction change devices that make it possible to change the directionality inside the vertical planes of the antennas at the base stations discretionarily and by providing a control device that controls the corresponding direction change devices, the size of zone where the base stations can communicate with the mobile stations can easily be changed whenever necessary.

-0020:

Also, by collectively controlling the zones of multiple base stations, control of the zone settings can be conducted fluidly in response to the number of calls when many calls occur.

-0021

-Actual Example: Below, an actual example of this invention is explained in detail, with reference to figures.

-0022:

Figure 4 is a block figure that indicates the structure of one actual example of this invention. Figure 5 is a block figure that indicates the structure of one actual example of an antenna used in this invention that is capable of changing discretionarily the directionality inside its vertical plane.

-0023:

In Figure 4, the base station is (1), the antenna is (3), the direction change circuit (19) changes the directionality inside the vertical plane of antenna (3), the control device (29) controls the direction change circuit (19), and the zones formed by base station (1) are indicated by (4) and (5). Also, (R1) indicates the distance from base station (1) to the edge of zone (5), and (R2) indicates the distance from base station (1) to the edge of zone (4).

-0024:

In Figure (4), in the condition where mobile communication service is being carried out and base station (1) forms zone (4), (R1) is the distance from base station (1) to the edge of zone (4) which is formed by radio waves emitted by antenna (3). When the zone formed by base station (1) is to be changed to zone (5),

the edge of which is distance (R2) from base station (1), the change can be accomplished through the control of control device (29), which activates direction change circuit (19) and changes the directionality inside the vertical plane of antenna (3).

-0025:

Zones can be easily be changed without regard to weather or the location of the antenna (3) if the control device (29) is installed inside base station (1), for example indoors. Moreover, it is possible to change the zones of multiple base stations from one spot by extending the control lines and condensing the control devices for multiple base stations at a single spot outside the given base stations.

-0026:

Figure 5 is used to explain the structure of the above-mentioned direction change circuit (19) and how the control device (29) is operated to change the directionality of the antenna (3) and control of the base stations' zones.

-0027:

In Figure 5, the array antenna is (3-1), the antenna device (16) is arranged in array form inside the array antenna (3-1), and the direction change circuit (19) changes the directionality inside the vertical plane of the antenna (3). The variable phase shifters (24), (25), (26), and (27) change the phases which are set inside the direction change circuit (19). The control device (29) controls the phase shifters (24), (25), (26), and (27). The control line (28) connects the control device (29) and the phase shifters (24), (25), (26), and (27). The power distributor (37) is located inside the direction change circuit (19). The power supply lines (20), (21), (22), and (23) uZ connect the array antenna (3-1) with the direction change circuit (19). The power supply points of the array antenna (3-1) are (12), (13), (14), and (15). The antenna device (16) is part of the array antenna (3-1). The directionality of the inside plane of the antenna is indicated by (17) and (18). Also, Ø is the phase of the transmission signal that is supplied to power supply point (6). Ø-Ø1 is the phase of the transmission signal that is supplied to power supply point (12) of the antenna. Ø-Ø2 is the phase of the transmission signal that is supplied to the power supply point (13) of antenna. Ø-Ø3 is the phase of the transmission signal that is supplied to the power supply point (14) of the antenna. Ø-Ø4 is the phase of the transmission signal that is supplied to the power supply point (15) of the antenna. θ 1 indicates the angle of antenna directionality 17 from the horizontal position of the antenna. θ 2 indicates the angle of the antenna directionality 18 from the horizontal position of the antenna.

-0028:

The phase of the transmission signals supplied to supply points (12), (13), (14), and (15) of the array antenna can be changed with phase shifters (24), (25), (26), and (27) so that they become Ø-Ø1, Ø-Ø2, Ø-Ø3, and Ø-Ø4, respectively, in terms of phase Ø of the transmission signal that is supplied to power supply point (6). By changing the phase of this transmission signal, the directionality of the antenna is controlled. Further, the delay caused by the power supply line is taken into consideration at this time.

-0029:

The control device (29) controls the amount of the change in the phase of the transmission signal that the phase shifters supply to the antenna device. Stored in the memory of the control device (29) are: (a) each phase amount that is required by the phase shifters (24), (25), (26), and (27) to make the directionality of radio waves emitted from the array antenna (3-1) equal to Ø1, and (b) each phase amount that is required by the phase shifters (24), (25), (26), and (27) to make the directionality of radio waves emitted from the array antenna (3-1) equal to Ø2. When the directionality of the antenna is input into the control device (29), the control device (29) selects each phase amount that is required by the phase shifters (24), (25), (26), and (27) to produce the directionality that was input, changes the phase of the transmission signal supplied to the antenna, and obtains the desired directionality.

-0030:

The structure of this kind of invention makes it possible to change the directionality inside the vertical plane of the antenna, or in other words, to change the size of the zone, while maintaining service connections.

-0031:

Not only can each phase required by the phase shifters (24), (25), (26), and (27) be stored in the memory of the control device (29) and then merely be output, but the system can also be structured so that each phase required by the phase shifters (24), (25), (26), and (27) can be derived by arithmetical calculation. In this case, it is possible for the control device (29) to continuously

change the phases of the phase shifters (24), (25), (26), and (27).

-0032:

Figure 6 explains the combined control of the zones of multiple base stations.

-0033:

In Figure 6, zones (30) and (33) are changed at base station A. Zones (31) and (34) are changed at base station C, and zones (32) and (35) are changed at base station B. The control device (36) collectively manages and controls the directionality of the antennas at each base station.

-0034:

Figure 6 shows the placement of direction change circuits, organized as shown in Figure 4, at multiple adjacent base stations, and the unified management of the multiple base stations' zones through a control device that collectively manages the direction change circuits.

-0035:

In Figure 6, mobile communication service is provided with base station A changing zone (30), base station C changing zone (31), base station B changing zone (35). At this time, a large number of calls are occurring at base station A and base station B, and so the frequencies assigned to base station A and base station B have become insufficient, while there is a surplus in the frequencies assigned to base station C. At this time, the control device (36) collectively controls the changes in the directionality inside the vertical planes of the antennas of each base station, so that base station A is changed to the relatively smaller zone (33), base station B is changed to the relatively smaller zone (35), and base station C is changed to the relatively larger zone (34). Thus, by making the zones of base stations A and B relatively smaller and making the zone of base station C relatively larger, some of the mobile stations that had communicated with base stations A and B now communicate with base station C. In this way, it is possible to divert the traffic of base stations A and B to base station C. This change can be made while continuing the service of base stations A, B, and C.

-0036:

When using this invention's zone-changing system, because the zone of base station C is made larger, it is conceivable that a problem may occur due to radio wave interference with other base stations that use the same frequencies as those assigned to base station C. However, this type of problem can be avoided by assigning frequencies so that radio wave interference does not occur even when the zone of base station C is changed to zone (34). It is possible to utilize frequencies and provide service effectively if the minimum required amount of frequencies is assigned to each base station through careful assignment.

-0037:

As explained above, this invention makes it possible to easily control the size of the zones by controlling the direction change circuits and changing the directionality inside the vertical planes of the antennas at the base stations. Moreover, it is possible to change the size of the zones without regard to the weather or the location of the antennas, since it is unnecessary to switch the power supply lines.

-0038:

Moreover, it is possible to divert traffic that has become concentrated at a particular base station by using the control device that collectively manages multiple base stations in a unified fashion.

-0039:

Further, the explanation of this actual example includes an explanation of the usage of direction change circuits that electrically change the directionality inside the vertical plane of the antennas for the purpose of changing the zones of the base stations. However, this invention is not restricted to the use of this type of direction change circuit. For example, it is also possible to use direction change circuits that vertically change the direction of the antennas by mechanically tilting the antennas' angles of attachment. In this case, it is also possible to change the size of the zones by controlling the direction change circuits so that they change the antennas' angles of attachment.

-0040:

-Effects of Invention: This invention makes it possible to easily control the size of zones at base stations by controlling the direction change circuits and easily changing the directionality inside the vertical planes of the antennas. Moreover, it is possible to change the size of the zones without regard to the weather or the location of the antennas, since it is unnecessary to switch the power supply lines.

-0041:

Moreover, it is possible to divert traffic that has become concentrated at a particular base station by using the

control device that collectively manages multiple base stations in a unified fashion.

Brief Explanation of Figures

-Figure 1:

Illustrates the zones that the base stations form.

-Figure 2:

Illustrates the case in which the number of base stations is increased.

-Figure 3:

A block figure that indicates the conventional structure that forms the directionality inside the vertical plane of the antenna.

-Figure 4:

A block figure that indicates the structure of one actual example of this invention.

-Figure 5:

A block figure that indicates the structure of one actual example of an antenna used by this invention that is capable of changing discretionarily the directionality inside its vertical plane.

-Figure 6:

Illustrates this invention's collective control of multiple base stations' zones.

Numbers/Symbols used in figures:

(1) Base station
(2), (7), (37) Power distributor
(3) Antenna
(3-1) Array antenna
(4), (5), (30), (31), (32), (33), (34), (35) Zones
(6) Power supply point that connects transmitters
(8), (9), (10), (11) Power supply lines
(12), (13), (14), (15) Power supply points of array antennas
(16) Antenna device
(17), (18) Directionality inside the vertical plane of the antenna
(19) Direction change circuits
(20), (21), (22), (23) Power supply lines that connect an array antenna and direction change circuits
(28) Control lines
(29) Control device
(36) Control device that collectively controls multiple base stations
Ø, Ø-Ø1, Ø-Ø2, Ø-Ø3, and Ø-Ø4: Phase of transmission signal
θ 1 and θ 2: Angle of directionality inside an antenna's vertical plane from the horizontal position of the antenna
R1, R2, RA, RA', RB, RB': The distance from a base station to the edge of its zone